

3 TERMS

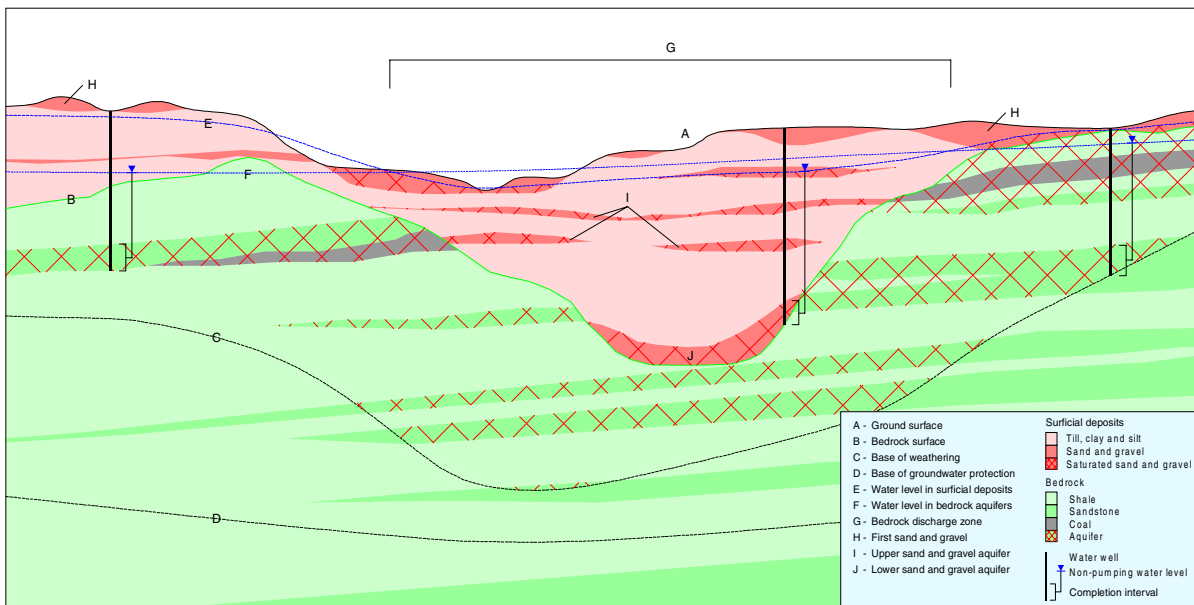


Figure 5. Generalized Cross-Section (for terminology only)

Lithology	Lithologic Description	Group and Formation		Member		Zone	
		Thickness (m)	Designation	Thickness (m)	Designation	Thickness (m)	Designation
[Sand and gravel, till, clay, silt]	sand, gravel, till, clay, silt	<100	Surficial Deposits	<100	Upper	<50	First Sand and Gravel
				<80	Lower		
[Sandstone, siltstone, shale, coal]	sandstone, siltstone, shale, coal	<130	Oldman Formation		Dinosaur Member	<0-25	Lethbridge Coal Zone
					Upper Siltstone Member		
					Comrey Member		
[Sandstone, shale, coal]	sandstone, shale, coal	<180	Belly River Group	Foremost Formation	<70	Birch Lake Member	Taber Coal Zone
					<60	Ribstone Creek Member	
					<50	Victoria Member	
					<15	Brosseau Member	McKay Coal Zone
[Shale, siltstone]	shale, siltstone	40-80	Lea Park Formation				
[Sandstone, siltstone, shale, coal]	sandstone, siltstone, shale, coal	40-140	Milk River Formation				
[Shale, siltstone]	shale, siltstone		Colorado Group				

Figure 6. Geologic Column

## 4 METHODOLOGY

### 4.1 Data Collection and Synthesis

The AEP groundwater database is the main source of groundwater data. The database includes the following:

- 1) water well drilling reports;
- 2) aquifer test results from some water wells;
- 3) location of some springs;
- 4) water well locations determined during water well surveys;
- 5) chemical analyses for some groundwaters;
- 6) location of flowing shot holes;
- 7) location of structure test holes; and
- 8) a variety of data related to the groundwater resource.

The main disadvantage to the database is the absence of quality control. Very little can be done to overcome this lack of quality control in the data collection, other than to assess the usefulness of control points relative to other data during the interpretation. Another disadvantage to the database is the lack of adequate spatial information. However, unlike other areas in the Province where there are numerous duplicate records, the present database for the County contains less than 20 duplicate water well IDs.

The AEP groundwater database uses a land-based system with only a limited number of records having a value for ground elevation. The locations for records usually include a quarter section description; a few records also have a land description that includes a Legal Subdivision (Lsd). For digital processing, a record location requires a horizontal coordinate system. In the absence of an actual location for a record, the record is given the coordinates for the centre of the land description.

The present project uses the 10TM coordinate system. This means that a record for the NE ¼ of section 23, township 052, range 02, W4M, would have a horizontal coordinate with an Easting of 319,230 metres and a Northing of 5,936,986 metres, the centre of the quarter section. If the water well has been positioned by the Prairie Farm Rehabilitation Administration (PFRA) as a result of field verification, the location will be more accurate, possibly within several 10s of metres of the actual location. Once the horizontal coordinates are determined for a record, a ground elevation for that record is obtained from the 1:20,000 Digital Elevation Model (DEM) from the Resource Data Division of AEP.

**After assigning spatial control for the ground location for the records in the groundwater database, the data are processed to determine values for hydrogeological parameters.** As part of the processing, obvious keying errors in the database are corrected.

Where possible, determinations are made from individual records for the following:

- 1) depth to bedrock;
- 2) total thickness of sand and gravel;
- 3) thickness of first sand and gravel when present within one metre of ground surface;
- 4) total thickness of saturated sand and gravel; and
- 5) depth to the top and bottom of completion intervals.

Also, where sufficient information is available, values for apparent transmissivity<sup>3</sup> and apparent yield<sup>4</sup> are calculated, based on the aquifer test summary data supplied on the water well drilling reports. Where valid detailed aquifer test results exist, the interpreted data provide values for aquifer transmissivity and effective transmissivity.

The EUB well database includes records for all of the wells drilled by the oil and gas industry. The information from this source includes:

- 1) spatial control for each well site;
- 2) depth to the top of various geological units;
- 3) type and intervals for various down-hole geophysical logs; and
- 4) drill stem test (DST) summaries.

Values for apparent transmissivity, apparent yield and hydraulic conductivity are calculated from the DST summaries.

Published and unpublished reports and maps provide the final source of information to be included in the new groundwater database. The reference section of this report lists the available reports. The only digital data from publications are from the Geological Atlas of the Western Canada Sedimentary Basin (Mossop and Shetsen, 1994). These data are used to verify the geological interpretation of geophysical logs but cannot be distributed because of a licensing agreement.

## 4.2 Spatial Distribution of Aquifers

Determination of the spatial distribution of the aquifers is based on:

- 1) lithologs provided by the water well drillers;
- 2) geophysical logs from structure test holes;
- 3) wells drilled by the oil and gas industry; and
- 4) data from existing cross-sections.

The identification of aquifers becomes a two-step process: first, mapping the tops and bottoms of individual geological units; and second, identifying the porous and permeable parts of each geological unit in which the aquifer is present.

After obtaining values for the elevation of the top and bottom of individual geological units at specific locations, the spatial distribution of the individual surfaces can be determined. Digitally, establishment of the distribution of a surface requires the preparation of a grid. The inconsistent quality of the data necessitates creating a representative sample set obtained from the entire data set. If the data set is large enough, it can be treated as a normal population and the removal of extreme values can be done statistically. When data sets are small, the process of data reduction involves a more direct assessment of the quality of individual points. Because of the uneven distribution of the data, all data sets are gridded using the Kriging<sup>5</sup> method.

The final definition of the individual surfaces becomes an iterative process involving the plotting of the surfaces on cross-sections and the adjusting of control points to fit with the surrounding data.

The porous and permeable parts of the individual geological units have been mainly determined from geophysical logs.

<sup>3</sup> For definitions of Transmissivity, see glossary

<sup>4</sup> For definitions of Yield, see glossary

<sup>5</sup> See glossary

### 4.3 Hydrogeological Parameters

Water well records that indicate the depths to the top and bottom of their completion interval are compared digitally to the spatial distribution of the various geological surfaces. This procedure allows for the determination of the aquifer in which individual water wells are completed. When the completion interval of a water well cannot be established unequivocally, the data from that water well are not used in determining the distribution of hydraulic parameters.

After the water wells are assigned to a specific aquifer, the parameters from the water well records are assigned to the individual aquifers. The parameters include non-pumping (static) water level (NPWL), transmissivity and projected water well yield. The total dissolved solids, chloride and sulfate concentrations from the chemical analysis of the groundwater are also assigned to applicable aquifers.

Once the values for the various parameters of the individual aquifers are established, the spatial distribution of these parameters must be determined. The distribution of individual parameters involves the same process as the distribution of geological surfaces. This means establishing a representative data set and then preparing a grid. Even when only limited data are available, grids are prepared. However, the data from these grids must be used with extreme caution because the gridding process can be unreliable.

#### 4.3.1 Risk Criteria

The main source of groundwater contamination involves activities on or near the land surface. The risk of groundwater contamination is high when the near-surface materials are porous and permeable and low when the materials are less porous and less permeable. The two sources of data for the risk analysis include (a) a determination of when sand and gravel is or is not present within one metre of the ground surface, and (b) the surficial geology map. The presence or absence of sand and gravel within one metre of the land surface is based on a geological surface prepared from the data supplied on the water well drilling reports. The information available on the surficial geology map is categorized based on relative permeability. The information from these two sources is combined to form the risk assessment map. The criteria used in the classification of risk are given in the adjacent table.

Surface Permeability	Sand or Gravel Present - Top Within One Metre Of Ground Surface	Groundwater Contamination Risk
Low	No	Low
Moderate	No	Moderate
High	No	High
Low	Yes	High
Moderate	Yes	High
High	Yes	Very High

**Table 3. Risk of Groundwater Contamination Criteria**

### 4.4 Maps and Cross-Sections

Once grids for geological surfaces have been prepared, various grids need to be combined to establish the extent and thickness of individual geological units. For example, the relationship between an upper bedrock unit and the bedrock surface must be determined. This process provides both the outline and the thickness of the geological unit.

Grids must also be combined to allow the calculation of projected long-term yields for individual water wells. The grids related to the elevation of the NPWL and the elevation of the top of the aquifer are combined to determine the available drawdown<sup>6</sup>. The available drawdown data and the transmissivity values are used to calculate values for projected long-term yields for individual water wells, completed in a specific aquifer.

<sup>6</sup> See glossary

Once the appropriate grids are available, the maps are prepared by contouring the grids. The areal extent of individual parameters is outlined by masks to delineate individual aquifers. Appendix A includes page-size maps from the text, plus additional page-size maps and figures that support the discussion in the text. A list of maps and figures that are included on the CD-ROM is given in Appendix B.

Cross-sections are prepared by first choosing control points from the database along preferred lines of section. Data from these control points are then obtained from the database and placed in an AutoCAD drawing with an appropriate vertical exaggeration. The data placed in the AutoCAD drawing include the geo-referenced lithology, completion intervals and NPWLs. Data from individual geological units are then transferred to the cross-section from the digitally prepared surfaces.

Once the technical details of a cross-section are correct, the drawing file is moved to the software package CorelDRAW! for simplification and presentation in a hard-copy form. These cross-sections are presented in this report and as poster-size drawings forwarded with this report. The cross-sections also are in Appendix A, and are included on the CD-ROM; page-size maps of the poster-size cross-sections are included in Appendix D of this report.

#### **4.5 Software**

The files on the CD-ROM have been generated from the following software:

- Acrobat 4.0
- ArcView 3.1
- AutoCAD 14.01
- CorelDRAW! 8.0
- Microsoft Professional Office 97
- Surfer 6.04